Project Title: Sustainable, High Energy Density, Low Cost Electrochemical Energy Storage Metal Air
Organization: Arizona State University
Funding Amount: $5,133,150
Website: http://engineering.asu.edu/macme

Brief Description of Project

The strategic vision of the Metal-Air Ionic Liquid (MAIL) battery program is to create a measurably safe, earth-abundant and geo-politically sustainable, ultra-high energy density, and low cost battery technology. MAIL batteries will have unparalleled safety because the oxidant and reductant are not stored in the same space, hence, in the event of a crash involving an electric vehicle, the risk of catastrophic energy release and fire is non-existent. The MAIL Battery will have a minimum energy density of 4-11 times that of Li-ion, and a long-term cycle life goal of 2600 cycles.

The transformational nature of the MAIL program extends beyond safety and energy density. By developing battery chemistry with focus on sustainability and domestic interests, we have the potential to make energy storage both cost effective and break the cycle of geopolitical liability with respect to fossil fuels and (on the horizon) non-domestic and narrowly located Li-reserves. The program is composed of a tightly knit university-industry collaboration: generating jobs now, producing Ph.D.s in renewable energy for the future, and enhancing the rate of return of the ARPA-E investment.

Why ARPA-E Funding and Not Private Capital

This program involves the melding of ionic liquid basic science and metal-air battery technology, and as such involves several significant technical risks. Primarily these relate to the ability to recharge an ionic liquid based air battery. In the absence of the ARPA-E funding it would not be possible to fund this effort privately.

Uniqueness/Benefits of Technology

Lowest fundamental cost of any known battery technology

- Ultra-high energy density
- Safe: no runaway reactions possible
- Earth-abundant and domestically source-able materials

Addressable Market & Potential Customers

- Transportation electrification: ranges >800km become feasible.
- Potential customers are companies active in the EV and PHEV arenas: GM, Tesla, Think!, amongst others.
    - Stationary storage: Low-cost backup, demand response, peak-shave.
- Potential customers are hospitals, big-box stores, generally customer-side of the meter applications.
    - Renewables integration: firming, shift, decrease ramp. Potential customers: PV integrators and installers.
    - Portables: highest possible energy density, low-cost, safe. Potential customers: LG, Toshiba, Dell, Apple, HTC.

Key Team Member Bios

Cody Friesen (PI) - Friesen is a highly research-active Physical Electrochemist and Materials Scientist. He currently directs the Center for Renewable Energy Electrochemistry (a six faculty group). Friesen has received numerous awards: 2009 MIT TR35; 2009 Alumni of the Year Award ASU; 2008 Faculty Achievement Award; 2007 Faculty Mentor Award; 2007 New Innovator of the Year. He has a Ph.D. in Materials Science & Engineering from MIT. Fluidic Energy (FE) is a spin-out of Friesen's research group.

Dan Buttry- Buttry has been working at the interface between electrochemistry and materials science for nearly 30 years. His early work focused on basic studies of charge transport in thin films and at interfaces. His work has been supported by a number of funding sources, including NSF, ONR, AFOSR , DOE and the W. K. Keck Foundation. He has published over 100 papers, mentored nearly 50 MS and PhD students and postdoctoral fellows.

Karl Sieradzki - Sieradzki obtained a Ph.D. in Materials and Solid State Science from Syracuse University. His major research interests include metal dissolution and deposition, alloy corrosion, thermodynamics of surfaces and fracture of solids. He is generally credited for "inventing" nanoporous gold by dealloying and developing various electrodeposition growth techniques for conformal growth involving surfactants. He has over 140 refereed publications in on topics related to his major research interests.

Testimonials

An excerpt of a Technology Review article on the program: (http://www.technologyreview.com/energy/23877/): "…With the ability to eliminate evaporation, boost voltage and eliminate dendrites, "we're working now on taking it to the next level," says Friesen. "It's about taking everything we've done over the last four years and leveraging that work into a battery that looks and feels just like a lithium battery, but has energy densities far beyond that." This would mean that energy storage would no longer be a limiting factor for renewable energy, and electric vehicles that could travel 400 to 500 miles on a single charge, he says, "at a cost just a little over lead-acid batteries."

Schematics/Photos of Technology or Personnel